Eur J Vasc Endovasc Surg (xxxx) xxx, xxx

EDITORIAL

Learning from Artificial Intelligence and Big Data in Health Care

Since its introduction at the Dartmouth College Conference in 1956, tremendous advances in artificial intelligence (AI) have been made, leading to applications using big data (BD) in numerous fields from industry to finance, education, media, and telecommunications. In health care, the constant increase of computer data led professionals, hospitals and states to take into consideration the management of BD requiring AI and sophisticated technical platforms to run the information systems (IS) of hospitals together with extra-hospital data from connected devices.

AI in health care is needed as physician decisions are becoming more evidence based, relying on guidelines and large databases as opposed to solely schooling and expert opinion. Moreover, considering the rising costs of health care worldwide, current incentives are also changing. States and private insurance companies are switching from fee for service to plans that prioritise patient outcomes. The rise of AI and BD is also answering that need.

Together with data analysts, clinicians should now take over the development of AI and BD. If they fail to do so, it is likely they will be quickly overwhelmed by high performance proprietary systems from the commercial world, such as Google and Facebook. However, prerequisites are essential to make this digital transition.

Convergence of data requires collecting them from multiple heterogeneous hospital databases and making the necessary modifications to direct the data flows into a single BD warehouse. Subsequently, it is necessary to clean and apply the correct algorithm for AI with the help of data scientists (Fig. 1).

These new professions, at the interface of algorithm coding and statistical analysis, well beyond the scope of current biostatistical competencies, will lead to a major change at the very heart of the medical profession. In Europe, experience with BD health care is being built in pilot university hospitals with networks between various hospitals to analyse millions of data. In this context, feasibility studies involving the construction of cohorts leading to multicentre studies are the first steps in the use of AI and BD.

These steps are made possible by the introduction of AI and machine learning. AI is the ability of a machine to make an autonomous decision based on data collected with a self learning ability in repetitive data processing and adaptation to new data evolving over time. In machine learning, a model learns from examples rather than being programmed with rules. A key difference between human learning and machine learning is that humans can learn to make general associations from small amounts of data. For example, a child does not need many examples of a cat to differentiate it from a dog. Machines require many more examples than humans to learn the same task.

But AI for precise predictions about the distant future is sometimes risky. The rise and fall of Google Flu remind us that forecasting an annual event based on one year's data runs into time series problems. The apparent solution is to pile on greater varieties of data, including social, demographic, genomic, and mobile sensor records to a patient's history and web browsing logs.

By analysing BD, AI is constantly learning and introduces the concept of predictive medicine that has already proven itself in certain areas, such as imaging, cancer, and dermatology to name only a few. AI learning makes it possible to build diagnostic and therapeutic programmes adapted to a specific individual taking into account each of his or her clinical, biological, and even genetic characteristics.

The management of BD results in a basket of patients provided that the IS of hospitals makes its revolution by introducing new professions and pedagogical work to insert it into the clinical environment (Fig. 1). The interaction with medical practitioners is a key point to guide engineers to avoid irrelevant clinical data being analysed and thereby giving irrelevant results.

In Europe, the speed of implementation of these systems is not happening as quickly as expected. The necessary economic investments and the paradigm shift has taken time, especially as public authorities have also had to consider the protection of patient data within the European Union's General Data Protection Regulation, which came into effect in May 2018. Health systems have developed sophisticated mechanisms to ensure the safe delivery of pharmaceutical agents to patients. The wide applicability of AI and BD will require a similarly sophisticated regulatory oversight.

Hospitals in Paris are trialling BD and AI with machine learning systems to forecast admission rates, aiming for a more efficient deployment of resources and better patient outcomes. For this purpose, at four of the hospitals that make up the Assistance Publique-Hôpitaux de Paris (AP-HP), data from internal and external sources, including 10 years' worth of hospital admissions records and several external data sets such as weather, public holidays, and flu patterns have been crunched to come up with day and hour level predictions of the number of patients expected through the doors. AI was employed to determine which algorithms provide the best indicator of future trends when they are fed data from the past. The system, built upon an open source platform, resulted in a web browser based interface designed for doctors, nurses, and hospital administration not trained in data science, to forecast visit and admission rates for the next 15 days. Extra staff members were drafted in when high numbers of visitors were expected, leading to reduced waiting times for patients and a better quality of care.[1] With the cost of providing health care increasing at more than the rate of gross domestic product in every developed country, smart, intelligent systems like those of the AP-HP are likely to play an important part in the future of health care. By more accurately predicting the demand for services, waste can be reduced and insuring can become more efficient.

Following oncology with genetic profiling now being used to identify patients for whom tailored chemotherapy directed toward personal cancer mutation is used,[2] several applications derived from AI are to be expected in vascular surgery with the management of registries including clinical, biological, and imaging data. Ross *et al.*[3] built several models to identify peripheral arterial disease (PAD) that frequently goes undiagnosed.[4] They compared their models to standard logistic regression and showed that AI

https://doi.org/10.1016/j.ejvs.2020.01.019

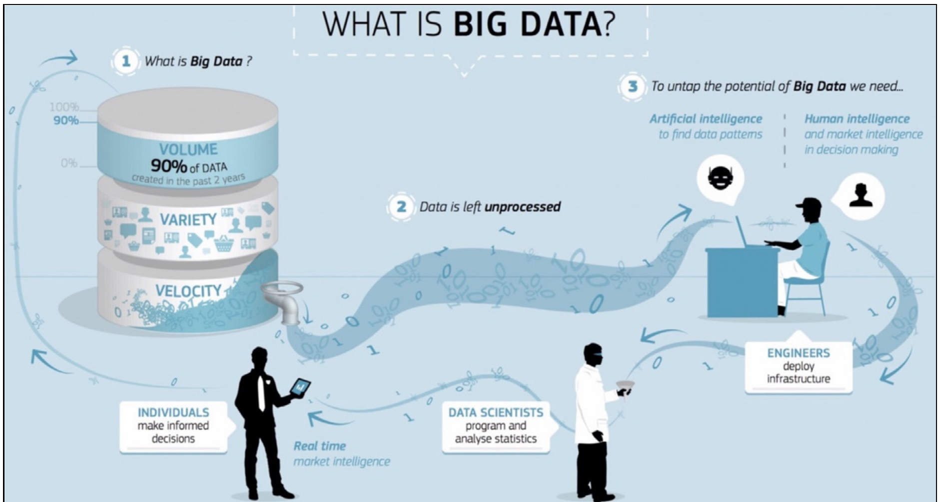

Figure 1. What is big data? Using big data requires not only artificial intelligence, but also people (1). Convergence of data requires collecting them from multiple heterogeneous databases to direct the data flows into a single big data warehouse (2). At this point, data are left unprocessed (3). Engineers deploy the infrastructure, clean the data, and make the data readable by an analysis tool with the help of data scientists. © European Commission. Research and Innovation (https://ec.europa.eu/growth/industry/innovation/business-innovation-observatory_en).

was able to produce more accurate classification and predictive models to identify patients with PAD and to predict mortality in a population for which strong risk prediction models are lacking. For example, Ross *et al.*[3] used a variety of patient data, including genomic, imaging, and socio-economic variables not obtainable within the usual clinical research pathway to identify patients at risk. As shown in the AP-HP experience, we will soon be able to provide real time predictive analysis for patient care in large data sets and to extract more granular information from the electronic health records with natural language processing techniques.[5]

In vascular surgery, imaging is a key step in the care provided to patients and several AI derived methods have been applied to improve aortic aneurysm segmentation, allowing precise characterisation of the aneurysm geometry with pre-operative modelling for endograft insertion or to evaluate the risk of aortic aneurysm growth and to predict outcomes after surgical repair.[6–8] Programmes have also been developed for image segmentation and risk stratification in patients with carotid artery stenosis.[9] Finally, AI has also been developed to enable simulation used for the training in vascular surgery.[10]

These examples prove that the development of AI together with BD is a major opportunity for vascular surgeons, as these techniques have the potential to improve patient care, evidence based medicine, education, and training. AI has raised promises but, on the downside, has created hype derived from fantasy. There remain many challenges to discover under the surface of the algorithm black box.

The involvement of vascular surgeons in these technological changes is therefore of utmost importance to guide vascular scientists and industry to develop relevant applications and guarantee a safe and tailored use in clinical practice.

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Please cite this article as: Ricco J-B et al., Learning from Artificial Intelligence and Big Data in Health Care, European Journal of Vascular and Endovascular Surgery, https://doi.org/10.1016/j.ejvs.2020.01.019